COLUMBIA Class Design for Sustainment

Product Support Manager Workshop

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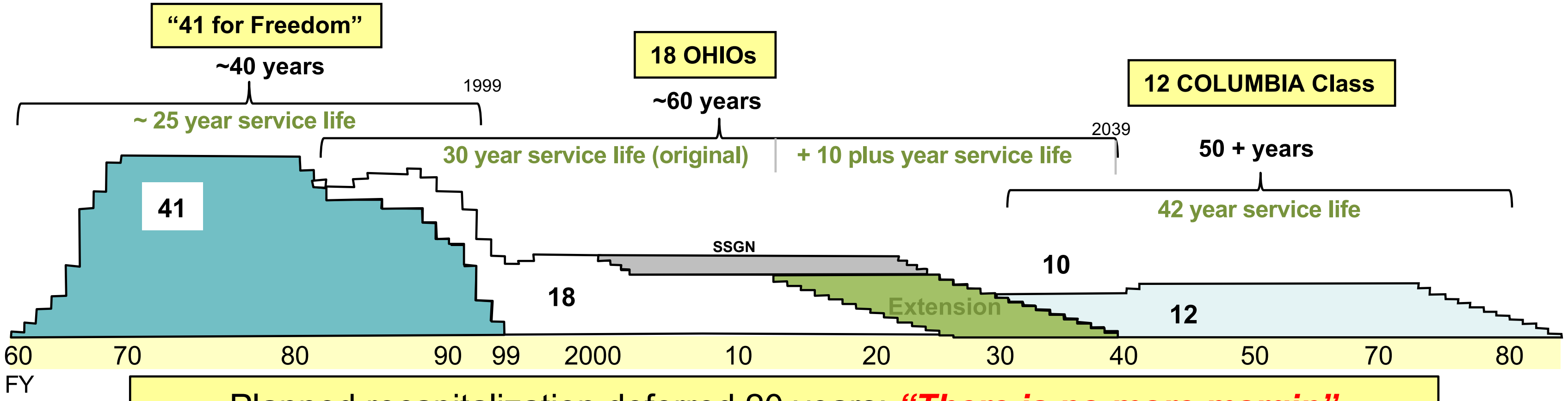
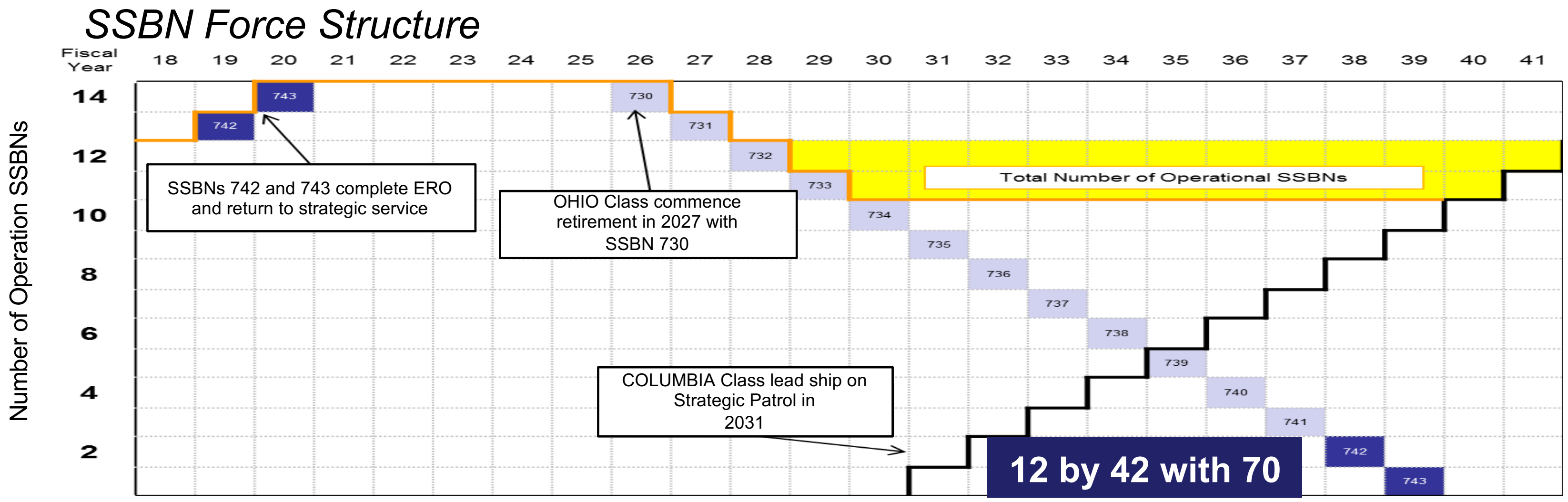
Critical Need for Recapitalization

Historical Sea Based Strategic Deterrent (SBSD) Force Structure



Planned recapitalization deferred 20 years; ***"There is no more margin"***



Outline

- Aspects of COLUMBIA Design for Sustainment
- Why is it important
- Why is it hard
- Getting the requirements right
- How COLUMBIA implemented
- Success stories
- Challenges

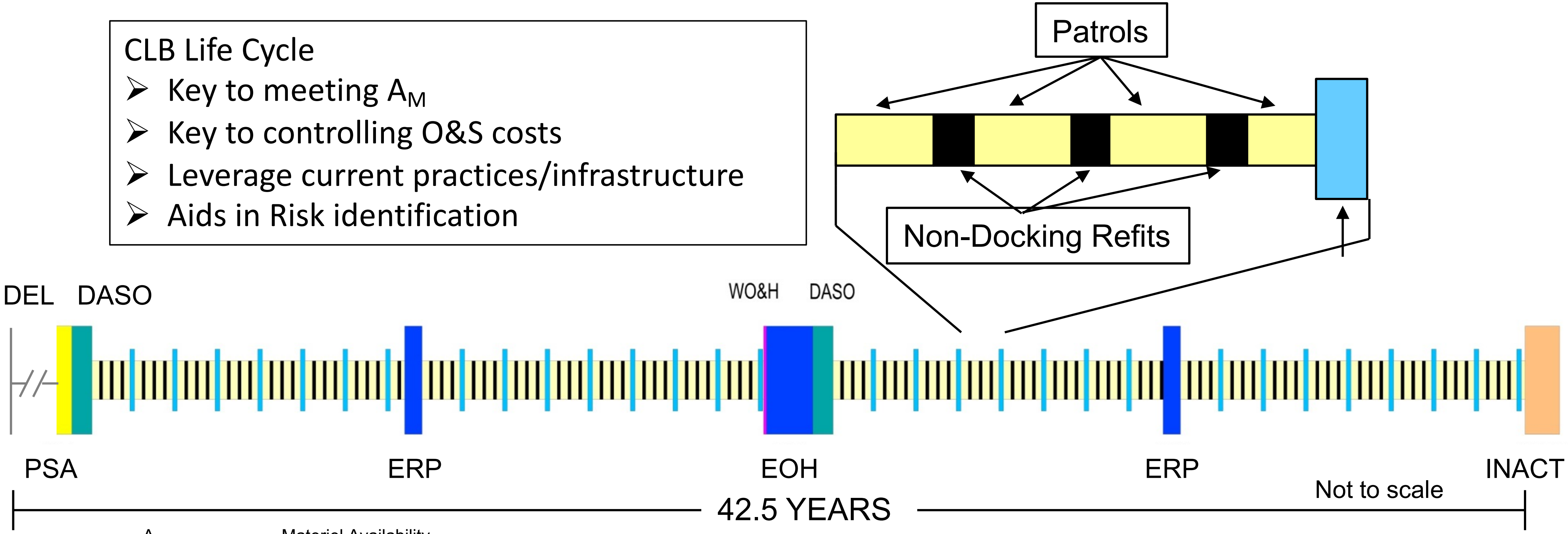
Aspects of Design for Sustainment

- Influence the design
  - Establish life cycle as a design constraint
  - Set Reliability, Availability and Maintainability (RAM) requirements
  - Design for maintainability
  - Full stakeholder involvement
  - Persistent SVL
- Build the support
  - Train the maintainers and develop maintenance plans
  - Prepare the maintenance (refit) facilities:
    - "The refit facilities must control their own destiny"
    - Ensure balance between organic ability, contractor support and off-site maintenance
    - Rotatable Sparing Pool Program
    - Facilities and Industrial Plant Equipment for new systems
    - TRIDENT Load List (retail level spares)
- Execute operations and sustainment plan

Ensure Refits are Successful Day One

COLUMBIA Life Cycle
Why DfS is Important

CLB Life Cycle
- Key to meeting A_M
- Key to controlling O&S costs
- Leverage current practices/infrastructure
- Aids in Risk identification



A_M	Materiel Availability
DASO	Demonstration & Shakedown Operations
DEL	Delivery
EOH	Engineered Overhaul
ERP	Extended Refit Period
INACT	Inactivation
PSA	Post Shakedown Availability

Early Sustainment Efforts Focused on Ensuring CLB can meet its Life Cycle

Why Designing for Sustainment is Hard

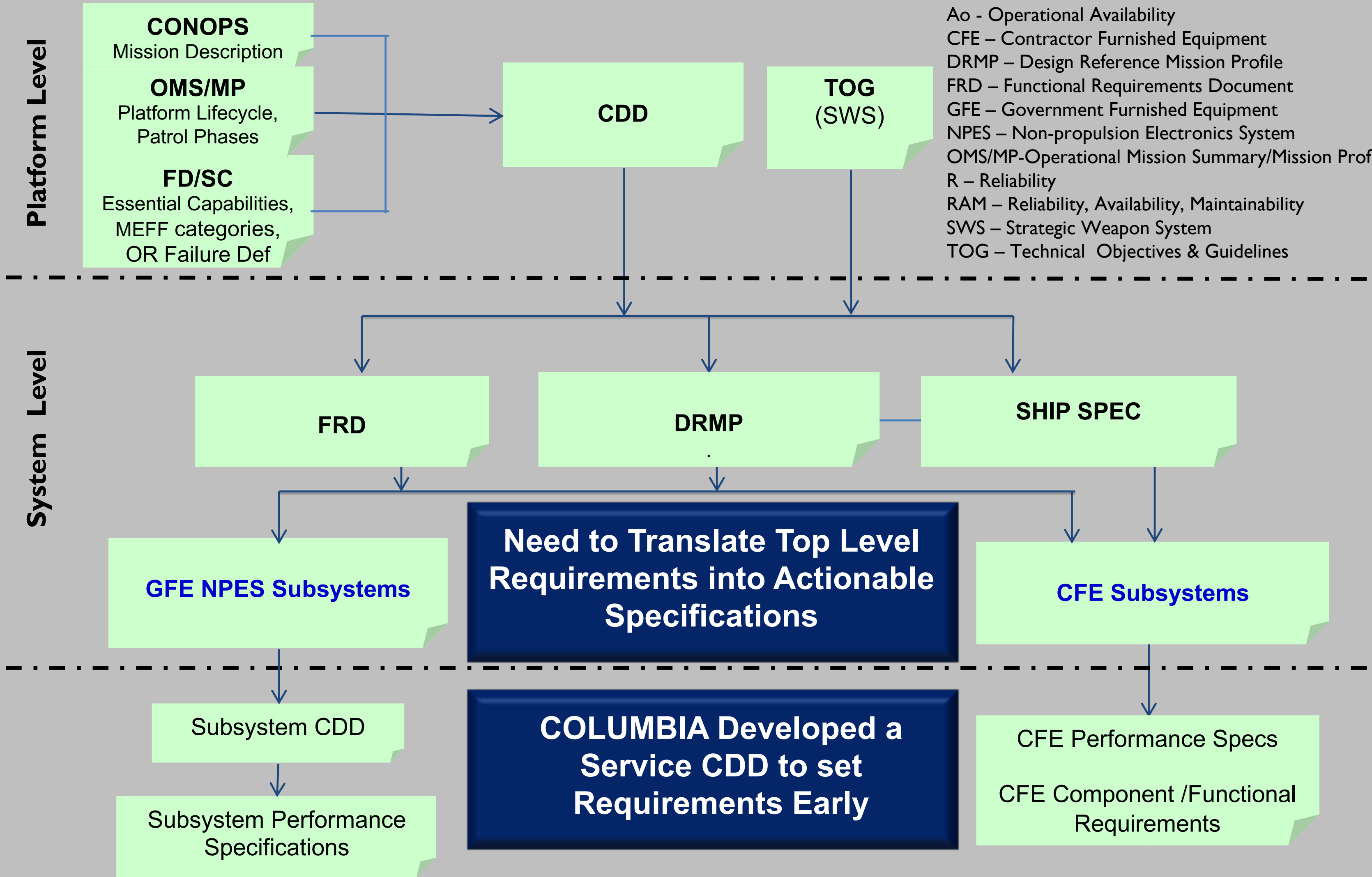
- **Early focus on minimizing NRE and construction costs**
  - Maintainable, supportable designs require more effort => inherent tension
- **Incentive to pull through existing designs from prior classes despite known fleet issues (reduces NRE; “proven/in-service design”)**
  - Pulling through prior design can also mean pulling through known supportability issues
- **Program schedule may pressure approval of a system that is not optimal for sustainment criteria => difficult choice**
  - Inherent cost/schedule/performance tension between systems engineering technical rigor and program schedule goals and incentives
- **Design agent and acquisition program manager/executive are often not the platform owners during the program’s sustainment phase**
  - FYDP pressure is near term. Sustainment challenges are in the out years
  - PEO COLUMBIA now owns the life cycle
- **Culture**
  - “My job is to get the boat down the river…after that it’s the Fleet’s problem”
- **Difficult to articulate when a design meets sustainment requirements**

Design for Sustainment – A “Top Level” Requirement

- **Sustainment metrics should be a PSM’s best friend**
- **COLUMBIA Class CDD Key Performance Parameter (KPPs)**
  - **Material Availability (A_M):** # of platforms ready for operational tasking
    - <u>Downtime is strongly affected by maintainability decisions made during system design</u>.
  - **Operational Availability (A_O):** Time a platform is available to accomplish tasking (focus is on duration, measured across at sea portion of patrol)
- **COLUMBIA Class CDD Key Supporting Attribute (KSAs)**
  - **Reliability (R_M):** Measure of the probability that the system will perform without failure over a specific interval
  - **O&S Costs**: Ensure that the operations and support (O&S) costs associated with Availability are considered in making decisions

Material Availability is Primary Performance Metric for COLUMBIA

Sustainment Requirements Flow-Down

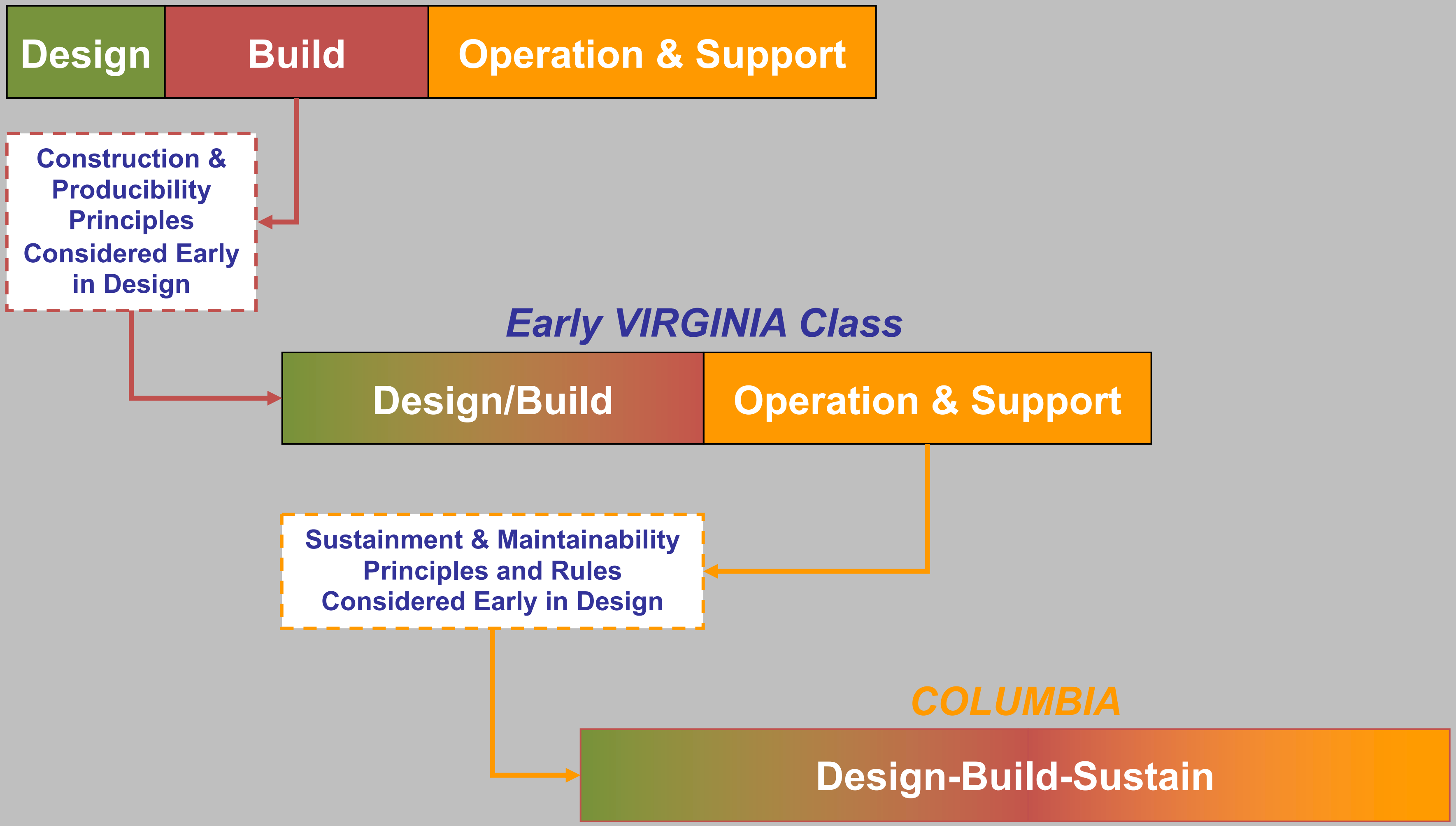


Ao - Operational Availability
CFE – Contractor Furnished Equipment
DRMP – Design Reference Mission Profile
FRD – Functional Requirements Document
GFE – Government Furnished Equipment
NPES – Non-propulsion Electronics System
OMS/MP-Operational Mission Summary/Mission Profile
R – Reliability
RAM – Reliability, Availability, Maintainability
SWS – Strategic Weapon System
TOG – Technical Objectives & Guidelines

Design for Sustainment – Baked into Contract Structure

- **RDT&E contract includes design for sustainment incentives**
  - **Even if the incentive is small, it provides an avenue to have a conversation**
- **Technical requirements invoked in contractor shipbuilding specifications to meet top level CDD KPP and KSA requirements**
  - **Life Cycle Portion of A_M**
    - Clearly disseminated the life-cycle constraints to design agent
    - GFI vs. provided as “guidance” in specification language
    - *Meeting life-cycle constraints is imperative to making A_M KPP*
  - **At-sea portion of A_M**
    - Operational Availability and platform reliability
    - Be able to stay at-sea for required duration
  - **Maintenance Requirements**
    - Shipboard equipment arrangement and maintenance features (focus on accessibility)
    - Equipment/reinstallation features (4hr/2hr/2hr/6hr); procedures requirements
    - TRIPER (designated rotatable pool)
- **Sustainment engineering team established by design agent**

Design / Build / Sustain

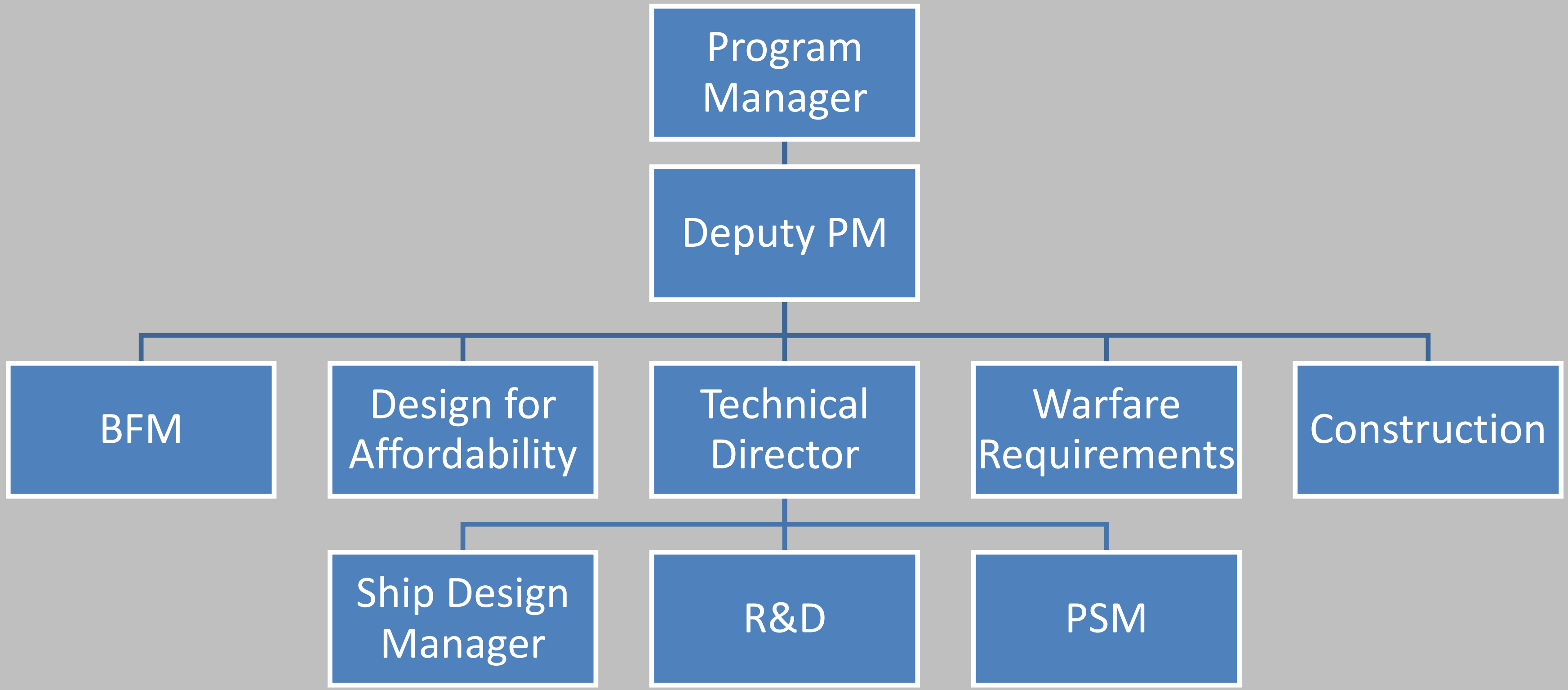


Build the Team

- **Life Cycle Support Team integral part of the Engineering/Design Teams**
  - Professional maintainers and logisticians embedded into design teams (design agent and government)
    - TRIDENT Refit Facility (TRF) Kings Bay and TRF Bangor maintainers and Portsmouth Naval Shipyard (PNSY) operations and planning part of team
    - Incorporated life cycle support training into the Design/Engineering Teams
  - Ship design project officers lead and champion sustainment throughout the design and shape the design to accomplish objectives

Enforceable Requirements Allows Design Team to be Co-Owners of Sustainment

Build the Team



Influence the Design – Be Part of the Design Team

Maintainer Integration During Design Phase

- **Legacy maintenance data provided to design team by in-service community**
  - Input to CLB system design
  - Aided in component selection/re-design
- **Maintainer/designer integration**
  - Refit Facilities hosted over 80 design team visits
  - Design agent hosted numerous maintainer reviews at their facility
  - Maintainers are members of the CLB Sustainment PIT
    - Sustainment PIT part of CLB arrangements team
    - Voice of the maintainer influences design
- **Assessing maintenance requirements early**
  - Pre-Construction Class Maintenance Plan
  - Life Cycle Technical Foundation Paper
    - Assess total man-days of maintenance required against capacity: can COLUMBIA meet the Life Cycle requirements?
  - Draft loading of first 33 refit periods

Three Stage Process Supporting Arrangements

Maintainability verified at several stages in the design

Stage One: Establishes the plan for how maintenance will be accomplished

- Identification lifting & handling (L&H) needs for removal items
- Reserve space for lifting pads and removal paths early
- Establish maintenance volumes for in-place repair/overhaul
- Identify items at risk for established maintenance time goals (4-2-2-6)

Stage Two: Validates the plan is still viable in the complete arrangement

- Identification of all interference items and validate compliance to ripout requirements
- Assess impacts to 4-2-2-6 time goals
- Validate the adequacy of handling features

Stage Three: Develop and issue life cycle product

- Equipment handling procedures and flowpath drawings

DfS Successes

- **Many at “no cost” – part of normal design “churn”**
  - Access to ventilation ducting for inspection/cleaning
  - Towed communications buoy motor foundation design for access
  - Battery well design
  - Shaft weight and handling
  - Self lubricated bearings
- **Several required additional funds**
  - Secondary propulsion unit reliability improvements
  - AMR1 redesign
  - Laundry room design
  - Topside cleats

Next Phase of Sustainment Challenges

- Obsolescence
- Using electronic design disclosure vs traditional 2D paper drawings
- Facilities
- Systemic underinvestment in “L”ogistics

Key Takeaways

- Be involved as early as possible during requirements setting – know the requirements
- Translate requirements to actionable design specs
- Set the culture and create sustainment vision
- Build the team